Level 3 Technical Level Programming
Maths for Programmers

Unit T/507/6469

SPECIMEN

Time allowed: 2 hours

Materials
For this paper you must have:
● pens
● pencils
● simple drawing instruments
● scientific calculator (non-programmable).

Instructions
● Use black ink or black ball-point pen.
● Fill in the boxes at the top of this page.
● Answer **all** questions.
● You must answer the questions in the spaces provided.
● Do not write outside the box around each page or on blank pages.
● Do all rough work in this book.
● Cross through any work you do not want to be marked.

Information
● There are two sections to this paper.
● Both sections should be attempted.
● Candidates should spend approximately 60 minutes on Section A and 60 minutes on Section B.
● The maximum mark for this paper is 80.
● The marks for the questions are shown in brackets.

Advice
● Please read each question carefully before starting.

Please write clearly in block capitals.

Centre number ⬚⬚⬚⬚⬚   Candidate number ⬚⬚⬚⬚

Surname _____

Forename(s) _____

Candidate signature _____

Section A

Answer **all** questions in this section.

Total for this section: 50 marks

In the multiple choice questions, only **one** answer per question is allowed.

For each answer completely fill in the circle alongside the appropriate answer.

CORRECT METHOD ⬤   WRONG METHODS ⊗ ⊙ ⊜ ⊘

If you want to change your answer you must cross out your original answer as shown. ⊠

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown. ⊗

| **0 1** | Which one of the following is also known as Base 8? |

A Denary ⬭

B Binary ⬭

C Octal ⬭

D Hexadecimal ⬭

[1 mark]

| **0 2** | Convert 111111112 into hexadecimal |

A FF00 ⬭

B 377 ⬭

C 255 ⬭

D FF ⬭

[1 mark]

0 3   In languages such as C, what is the prefix used to support the hexadecimal representation of constants?

A 0x ⬭

B + ⬭

C = ⬭

D &H ⬭

[1 mark]

0 4   A message with multiple parts in MIME format is likely to encoded in

A Base 8 ⬭

B Base 2 ⬭

C Base 64 ⬭

D Base 10 ⬭

[1 mark]

0 5   A computer is programmed to guess an integer between 1 and 50 inclusive. What is the probability of guessing the correct number twice in a row?

A 2/50 ⬭

B 2/100 ⬭

C 1/2500 ⬭

D 1/250 ⬭

[1 mark]

0 6   A binary value of 10010100 is stored in a CPU's register.
Convert this value to denary, interpreting in turn as:

6.1   an unsigned integer

6.2   two's complement

6.3   an unsigned binary fraction with a fixed central binary (radix) point

Use appropriate base notation in your answers.

[4 marks]

0 **7** Calculate the original base and the denary equivalent for each of the following:

7.1 $10101101_2 + 01011_2$

[2 marks]

7.2 $2416 - A16$

[2 marks]

7.3 $75_8 - 47_8$

[2 marks]

0 8

8.1 Complete the following truth table.

[3 marks]

X	Y	X.Y	X.Y + X	$\overline{X.Y + X}$
0	0			
0	1			
1	0			
1	1			

8.2 Identify the three logical operations used in the final column.

[1 mark]

0 9 Convert the following signed 8-bit binary numbers to their decimal equivalent.

9.1 10010001

[1 mark]

9.2 00001111

[1 mark]

1 0   This is a 16-bit diagnostic code:

0xCC12

10.1   Convert the diagnostic code to binary.

[1 mark]

Bits 14 and 15 indicate a fault condition. If both are True, there is a memory error.

10.2   What are the values of Bits 14 and 15?

[1 mark]

10.3   State whether there is a memory error and explain your reasons.

[2 marks]

1 1   State the three rules of recursion.

[3 marks]

1 2

12.1 Describe how an odd parity check works.

[2 marks]

12.2 Complete the following truth table for an odd parity generator.

[1 mark]

4-bit received message				Parity error check
A	B	C	P	
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	

1 3

13.1 Convert the following arithmetic expression to Reverse Polish notation (RPN).

3 * 2 + 5

[1 mark]

13.2 What is another name for RPN?

[1 mark]

1 4 Solve the following equation using the factorisation method.

$2x^2 + 5x = 12$

[3 marks]

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1 5 Express the following equation using the function notation.

[2 marks]

$y = x^2 + 5$

---

1 6 Name each type of matrix shown below.

[3 marks]

16.1 $\begin{bmatrix} 10 & 20 & 30 \end{bmatrix}$

16.2 $\begin{bmatrix} 10 \\ 20 \\ 30 \end{bmatrix}$

16.3 $\begin{bmatrix} 10 & 20 \\ 30 & 40 \end{bmatrix}$

_____

_____

1 7 Solve the following expression

[3 marks]

$2x - y$

where

$x = \begin{bmatrix} 7 & 8 \\ -5 & 0 \end{bmatrix}$ and $y = \begin{bmatrix} 2 & 4 \\ 7 & 8 \end{bmatrix}$

Show your working.

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1 8   Interpret the following:

$$\sum_{m=3}^{7} 2m$$

18.1   Name the symbol used and state its purpose.

[2 marks]

18.2   State the purpose of 'm'.

[1 mark]

18.3   State the start term and end term.

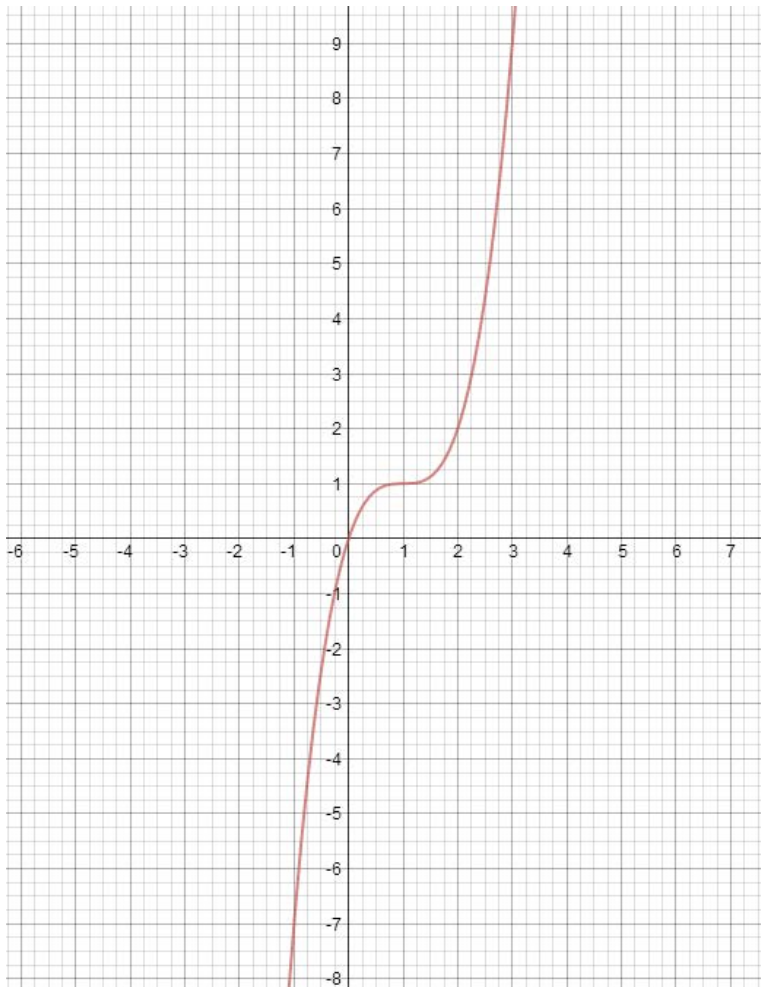**[1 mark]**

18.4   Calculate the total of the sequence.

[2 marks]

Section B

Answer **all** questions in this section.

Total for this section: 30 marks

1	9

You have been asked to incorporate an Exclusive OR (EOR/XOR) in a project's key circuit. Unfortunately, no Exclusive OR components are available.

You can build the exclusive OR logical operator using a combination of the following types of gate:

- 2 x NOT gates
- 2 x AND gates
- 1 x OR gate

19.1 Manipulate these gates into a working logic circuit which simulates an Exclusive OR. Label/annotate each gate's output.

[6 marks]

19.2 Complete a truth table, with entries for each gate, that proves the circuit is simulating the Exclusive OR correctly.

[2 marks]

19.3 Build the same Exclusive OR circuit using only NOR gates.

Note: you are not required to label this circuit.

[4 marks]

2 0

Examine the following graph which has been generated from the function

$f(x) = (x-1)^3 + 1$ on typical x and y axes:

20.1 Complete the following table for this equation:

[6 marks]

x	$f(x)$	(x,y)
−1	−7	
0		
1		(1,1)
2		

20.2 Calculate the value of $f(3)$. Show your working.

[2 marks]

20.3   State two differences between a function and an equation.

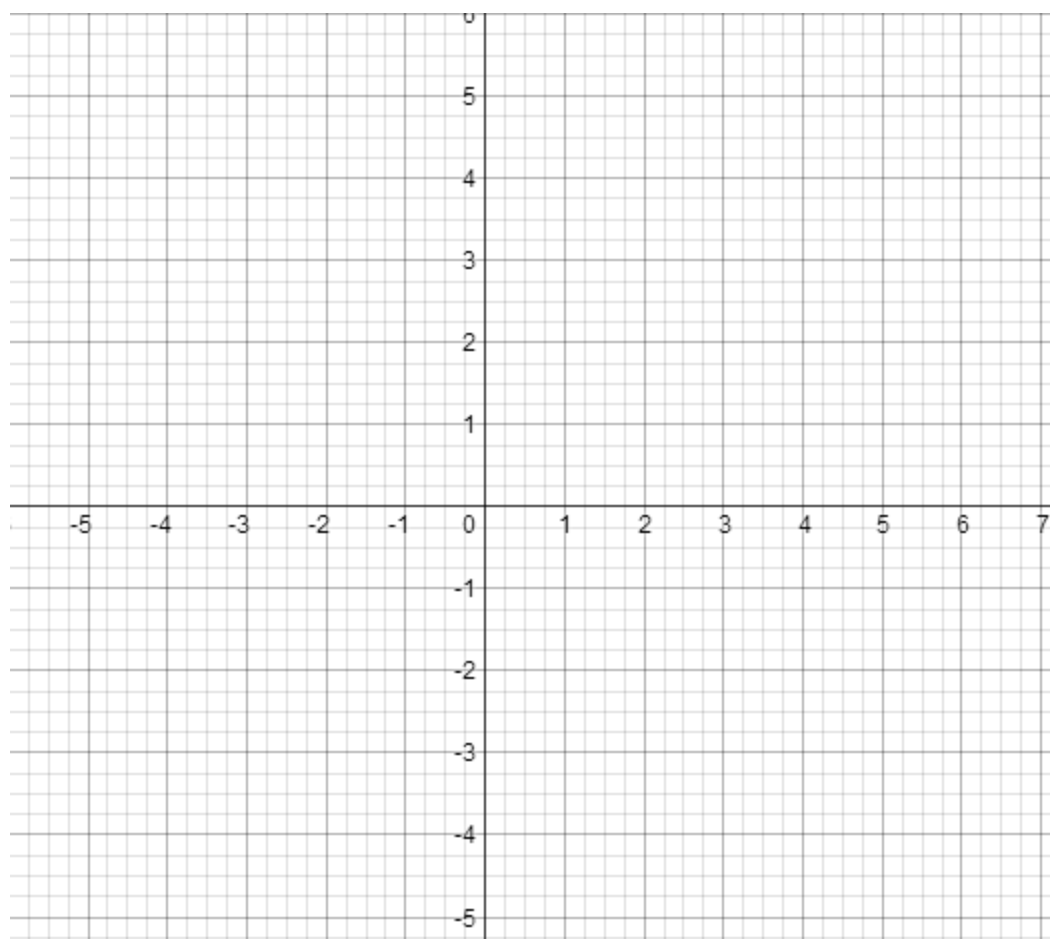**[2 marks]**

2 **1**   A graphics programmer is designing routines to transform simple line- based
graphics using matrix transformations.

They have plotted a simple square using the following co-ordinates which are
stored in a 4-column matrix.

$$\begin{bmatrix} x1 & x2 & x3 & x4 \\ y1 & y2 & y3 & y4 \end{bmatrix} = \begin{bmatrix} 2 & -2 & -2 & 2 \\ 2 & 2 & -2 & -2 \end{bmatrix}$$

21.1   Plot this square on the graph below, annotating each co-ordinate (x1, y1, etc)
clearly.

[2 marks]

21.2 Transform the square using the following reflection matrix to calculate its new co-ordinates:

$$\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$$

[2 marks]

21.3 Plot the new square on the same graph, showing the adjusted co-ordinates.

[2 marks]

21.4 State the type of reflection matrix that has been applied.

[1 mark]

21.5 Show the transformation matrix required to translate the square:

$x + 3$ and $y + 4$

[1 mark]

End of Questions